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PREPRINT

MAGNETIC UXO RECOVERY SYSTEM (MURS) (BRIEFING SLIDES)

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14. ABSTRACT The Magnetic UXO Recovery System (MURS) conceptual design was developed for a National Defense Center for Energy and Environment (NDCEE) task, funded by Environmental Security Technology Certification Program (ESTCP), and a partnership with AFRL/RXQF. Provides a brief overview of MURS - Automated Ordnance Excavator (AOE), electromagnet, power source, and the systems capabilities. Provides shakedown, live demonstration, cost analysis, and conclusion of robotic area clearance at the test area at Massachusetts Military Reservation (MMR).					
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Magnetic UXO Recovery System (MURS)

**UXO/Countermines/Range Forum
Orlando, FL, August 2009**

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Acknowledgements

- The MURS conceptual design was developed as part of an NDCEE Task in 2004.
- Current efforts have been funded by the ESTCP (project MM-732) and have allowed final design and fabrication of the system, as well as shakedown and demonstration.



Agenda

- Technology description and capabilities
- Shakedown
- Live demonstration
- Cost analysis
- Conclusions

Technology Description

The MURS consists of:

- Automated Ordnance Excavator (AOE)
 - Caterpillar 325L hydraulic excavator
 - Air Force Research Laboratory (AFRL) remote operation control system
- Electromagnet
- Power source
- Claw to facilitate extraction

Capabilities

- AOE
 - Weight: 60,000 pounds
 - Boom reach: 25 feet
 - Digging depth: 15 feet
 - Lift capacity: 10,000 pounds
 - Capable of remote operation from two miles away
- Electromagnet
 - Walker Magnetics Scrapmaster® D series 57-inch magnet
 - Magnetic field intensity of over 500 Tesla
- Power Source
 - 20kW diesel generator



Shakedown

- Tyndall AFB was chosen
 - Test range with ample space
 - “Clean” space, free from munitions
 - Next to fabrication shop
- Predominantly sandy soil
- Two areas 10 feet by 20 feet marked as demo areas
 - One left intact with the native soil
 - One excavated down to 4 feet and filled with clay
- Sparse to no vegetation in both areas

Shakedown

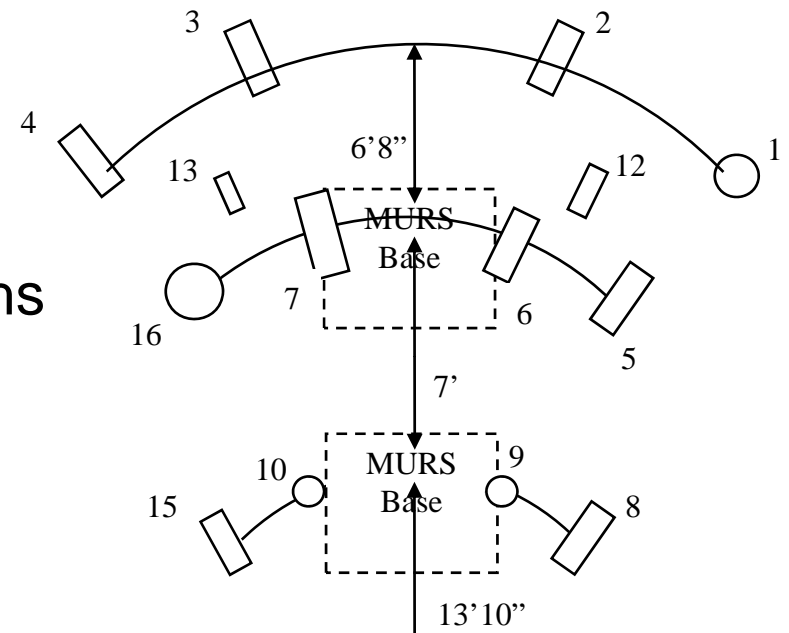
- Inert ordnance
- Pre-positioned to replicate a variety of potential scenarios
- Ordnance and scrap buried at different depths and orientations
 - 60mm mortars to 500-lb bombs for the excavation testing
 - 2000-lb bomb for determining lift capacity
- Shallow water (4 ft) in a plastic pool
 - 81mm mortar, 500-lb bomb, GATOR mine, and 105mm HEAT projectile

Shakedown

■ Inert UXO

- Some on the surface
- Most individually buried at depths down to 18 inches
- Orientation consisted of H, V-nose up, V-nose down, and 45-degree tilt to the vertical

ORDNANCE DESIGNATOR	DESCRIPTION	ORDNANCE DESIGNATOR	DESCRIPTION
1	M42	9	GATOR mine
2	BDU33	10	BLU26
3	105 mm HEAT	11	<i>Number not used</i>
4	105mm HEP	12	81mm mortar
5	8" projectile	13	75mm projectile
6	MK81 250lb bomb	14	<i>Number not used</i>
7	MK82 500lb bomb	15	60mm mortar
8	BLU3	16	Anti-Tank (AT) practice mine

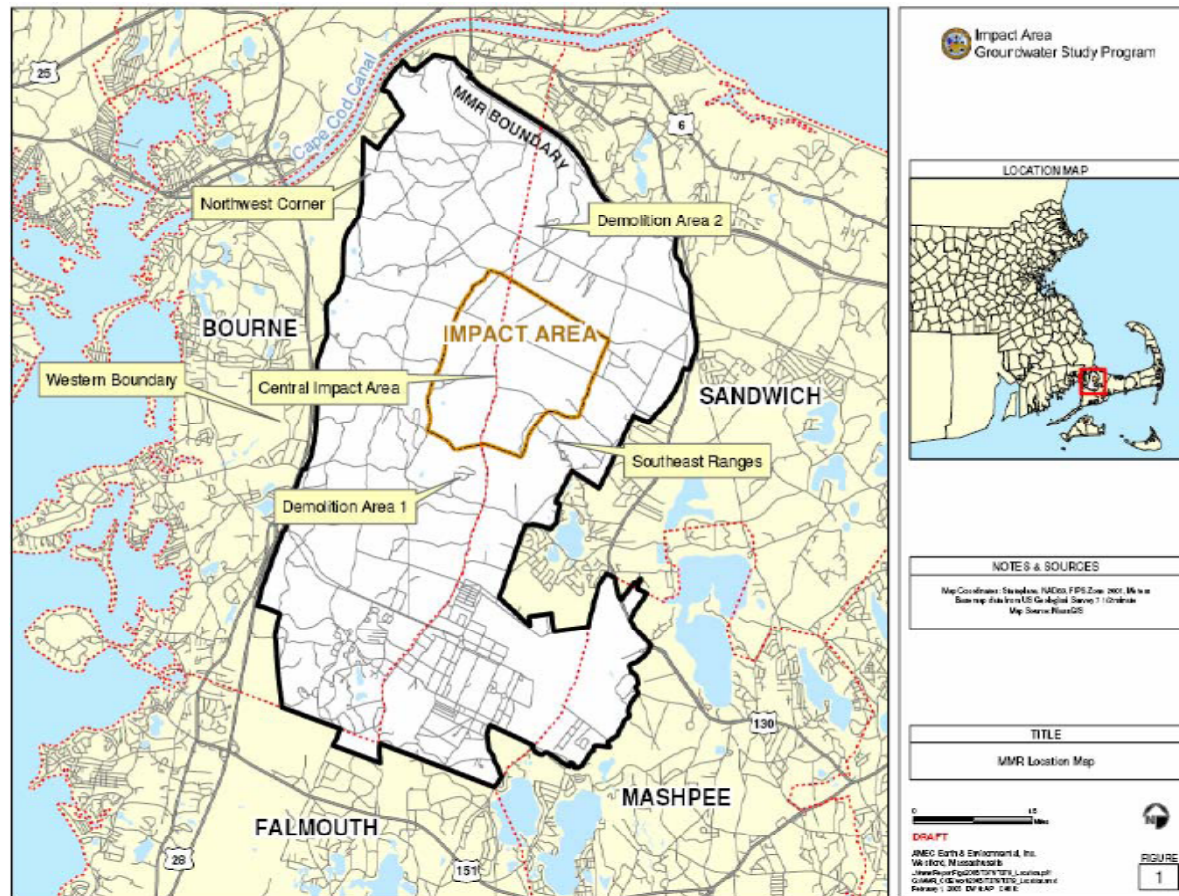


Shakedown

- Without using the claw, the MURS was able to retrieve UXO at approximately 6 inches buried depth in clay and 12 inches in sand.
- Using the claw, recovery of larger, buried items was documented up to 12 inches in clay.
- The larger ferrous objects were easier to attract with the magnet and easier to locate using the claw.
- Orientation of munitions in-situ appears to have an impact on effectiveness of the magnet.
- During the underwater testing, the 500-lb bomb and 105mm HEAT were retrieved from 16-18 inches of water; the GATOR mine from 22 inches; and the 81mm mortar from 24 inches.

Live Demonstration

- Massachusetts Military Reservation



Live Demonstration

- Central impact area
- Soil is naturally hummocky; includes craters from 60 years of range operations
- Very dense, mature scrub oak required range clearing
- 10 acres were gridded out in 1-acre plots; one of these plots was used to obtain data
- Potential UXO
 - 75/90/105/155mm artillery projectiles
 - 37/40/50/70/81mm, 3/4.2 inch mortars
 - HE, inert, and practice charges
 - TNT, Comp B, and black powder fillers

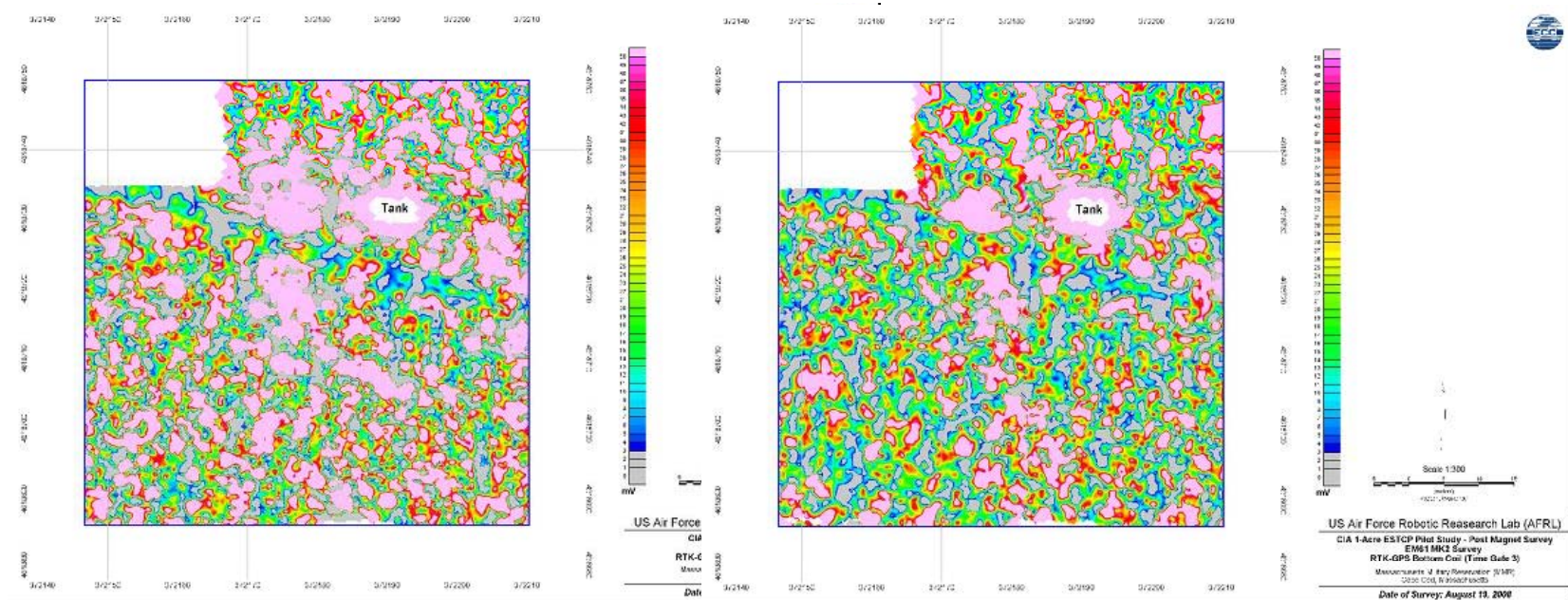
Live Demonstration - CONOPS

- Following mapping, drive MURS remotely to the contaminated site
- Place the magnet over the suspected UXO or range scrap
- Turn magnet on to extract UXO
- Place the “attached” UXO or scrap in a pre-determined place for disposal by the EOD team

Keeps EOD team safe during extraction stage

Live Demonstration

- EM-61 used prior to and after MURS



Performance Against Objectives

- Remote control operation deemed intuitive, easy to use by the operators. Training took less than 1.5 hour.
- Setup time required approximately 1 hour.
- MURS did not appear to damage the grassy surfaces it drove on.
- Removal rate was effective – on one occasion, MURS picked up six items in less than 10 minutes.
- No measurable remnant magnetic signature was detectable in soil.
- Reliability was good with only one problem in the 50 hours needed to clear the selected one acre.

Cost Analysis

Item/Phase	MURS	MURS/acre	Manual/acre
Tool	\$625,000	\$4,100	Negligible
Mob/demobilization	\$15,500	\$2,450	Negligible
Setup	\$1,100	\$110	Negligible
Operational costs		\$1,150	Negligible
Removal		\$8,000	\$43,350
Cost per acre		\$15,810	\$43,350
Cost per anomaly		\$103	\$293

Conclusions

Although line of sight appeared to limit MURS at times, the system was demonstrated to have the following attributes:

- Very cost-effective compared to manual method
- Reduces worker exposure/increases safety
- Can work in a variety of weather conditions including rain

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